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DESCRIPTION

OF THE

# ENCIRCLING LIGATURE APPARATUS

OF

DR. VON GRAEFE,

OF BERLIN;

WITH AN ACCOUNT OF THE VARIOUS MODES OF APPLICATION,  
AND A SUMMARY OF THE COMPARATIVE MERITS  
OF THE APPARATUS.



TRANSLATED FROM THE GERMAN,

BY

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## INTRODUCTION.

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THE frequent occasion for the use of instruments to apply ligatures in performing many of the most important surgical operations, has demonstrated to every operator the inefficiency, especially in the most difficult cases, of the various ingenious contrivances that have hitherto been employed for this purpose. I have long been endeavouring to remedy the obvious defects of these instruments; and I have at length succeeded in removing the obstacles, and overcoming the difficulties, that impeded my progress.

My apparatus will be found efficient in every possible case; in applying the ligature to external enlargements, and to internal and deep-seated tumours, be they soft or hard, firm or moveable, having a slender stem or a broad base; and whether it be desirable to cause only a gentle pressure, or a constriction to such a degree as entirely to destroy the encircled part.

The minute description which I have given of the construction, action, and method of using the apparatus, will enable the surgeon in some measure to form an opinion of its efficiency; not only in simple cases, but in those where the application of the ligature is attended with great difficulty. It will however require a practical experience of the powers of this well-tried apparatus fully to exemplify the facility, celerity, and certainty with which it may be employed; and the great benefit arising to the patient from its use, by the extreme diminution of pain in the operation.

DESCRIPTION  
OF THE  
ENCIRCLING LIGATURE APPARATUS.

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1. THE apparatus is for the most part made of fine silver, and consists of five pieces: viz., three ligature-holders—a short, a middle sized, and a long one—and two windlasses of different construction. In order to render their various combinations clearly understood, it is necessary to describe each separately.

OF THE HOLDERS.

2. The three holders (pl. I. figs. 1, 2, and 3) differ only in their length; a description of one will therefore suffice for all. At one end is a small projecting head (*a*, fig. 8), by means of which either windlass can be attached to it; at the other end is an eye (*a*, *b*, fig. 4) for the reception of the ligature. The short holder (fig. 1) is an inch-and-a-half in length; that of middle size (fig. 2), three inches; and the long one (fig. 3), full six inches; each being three lines diameter. If they were larger, the weight would be inconvenient; and if smaller, the two longer sizes would scarcely resist the strain of the ligature.

Each holder is perforated lengthwise at the eye end to the extent of half a line; whence a groove is formed, gradually becoming shallower, and terminating within one inch of the other end. The commencement of the groove is shewn at *b*, fig. 3; and its gradual diminution till it ends at *c*. Fig. 4 shews the eye (*a*, *b*) and the commencement of the groove. Fig. 5 shews the ligature forming a loop through the eye; the ends projecting from the groove. The eye (*a*, *b*, fig. 4) being



one line in diameter, is large enough not only to admit a common ligature, but for the reception of both ends of one of the strongest description. The tubular part between the eye and the commencement of the groove (*a*, *b*, fig. 3) should not be more than one line broad, in order that the end of the ligature may be quickly and easily passed in at *a* and out at *b*. The edges of the eye (*a*, *b*, fig. 4) should be carefully rounded, and made perfectly blunt, lest the ligature, when drawn tight, should be cut by the sharp edge; or the edge of the orifice be split by the pressure of the ligature, and thereby cause a failure. In either case an inattentive observer might attribute the effect to some other cause, and continue to introduce fresh ligatures until the defect in the construction of the instrument were discovered. Both the sides and edges of the groove also should be perfectly smooth and rounded, so that the holder feels, when rolled between the fingers, like a well-finished sound. There are two advantages arising from the length of the groove: it lightens the weight of the holders, and prevents the ligature from pressing against the surrounding parts.

The end to which the windlass is attached is left cylindrical and without a groove from *c* to *d*, fig. 3, in order to allow of a double female screw being cut internally for the reception of the male screw (*g*) of the forked, or screw windlass (fig. 9). The internal screw in fig. 3 is indicated by dotted lines (*c*, *d*). In figs. 6 and 7 is shewn the annular form of the head, which is not so distinctly visible in figs. 1, 2, and 3; and also the orifice of the internal screw, and the small semicircular aperture to receive the corresponding slide of the windlass. The relative position of these two apertures is distinctly seen in fig. 7. In fig. 8 is shewn the manner in which either windlass is attached to the holder: *a* is the annular head; *b*, *c*, the slide passed through the semicircular aperture therein; and *d*, the male screw of the windlass entering the internal screw of the holder.

#### OF THE WINDLASSES.

3. Either of the two windlasses can readily be adjusted to each holder. The one which acts by means of a double screw is

called the ligature screw; the other, which acts by a small cog-wheel and rack, the ligature winder.

#### THE LIGATURE-SCREW.

4. Fig. 9 is two inches long, and consists of two parts—the fork and the screw. The fork part includes the fork itself (*a*), the ring (*b*), and the slide (*d*), which form one piece. The division of the fork (*a*) is shewn at *c*. The ring (*b*) encloses the cylindrical bearing (*f*) of the screw part, so that it may be easily turned round by the handle (*e*). The slide (*d*), of which only one side is here shewn, is one line and a half broad, and so long that its rounded end (*d*) projects two lines beyond the screw (*g*). Its inner surface is concave, and adapts itself to the convex side of the holder, as is shewn at *c, d*, fig. 13. The slide should be sufficiently firm, without being too thick, that it may move easily backwards and forwards in the semicircular aperture in the head of the holder (vide fig. 7). When the screw is attached to the holder, the fork does not turn with the handle, being secured laterally by means of the slide; but it approaches or recedes from the head of the holder in a straight line, according to the action of the screw. Thus the turning of the whole apparatus close to the part encircled, as in the case of other contrivances for applying ligatures, is avoided.

The screw part (fig. 9) consists of the handle (*e*), the bearing (*f*), and the screw (*g*); forming together but one piece. The handle (*e*) is open, that it may be made of a convenient size without its weight being increased. The rounded bearing is only visible at *f*, it being almost entirely enclosed by the ring (*b*), in which it moves round easily in the proper direction, but is prevented by a rivet from moving in any other. The male screw, which extends from *f* to *g*, is one inch long, and fits the female screw in the holder (fig. 3, *c, d*). The thread of this screw is double, in order that it may act more quickly.

#### THE LIGATURE-WINDER.

5. Fig. 10 can be attached to either holder in the same manner as the ligature-screw. On one side (*a*) is seen a small cog wheel



with its usual stop and spring ; on the other side (*b*), part of the handle is visible ; and between the two sides is seen the roller, to which is affixed a very strong hook. The small tube (*d*) projecting from the centre of the flat or under side (*c*) fits into the circular orifice in the head of each holder ; and the small slide (*e*), which projects a little on one side of, and parallel to the tube, fits into the semicircular aperture, exactly as does the slide of the ligature screw, it being of the same size. The slide securely attaches the winder to the holder.

#### OF THE USE AND COMBINATION OF THE DIFFERENT PARTS.

6. Fig. 11 shews the way in which the ligature-winder can be used without the holder. The ligature forming a loop is seen at *a* ; its two ends, being passed through the small tube, are joined in a simple knot, and put in the hook on the roller ; so that by turning the handle, the ligature is drawn quite tight. It is used in this manner in simple cases of external application.

7. Fig. 12 shews the ligature-winder combined with the short holder ; at *a* is just seen the slide passed through the semicircular aperture in the head of the holder ; and which, together with the small tube fitted into the central orifice, joins the two firmly together. The ends of the ligature are put through the eye at *c*, and passing along the groove of the holder are tied in a knot and hung on the hook (*d*) of the roller. This holder is used when the ligature is to be applied to any part not very deeply seated ; or when it is desirable to have the winder near to the encircled part.

8. Fig. 13 shews the ligature-screw combined with the middle sized holder ; the slide (*c*) is passed through the semicircular aperture in the head of the holder and extends to *d* ; at *b* the male screw is shewn entering the internal screw of the holder. The ligature is seen forming a loop at *a*, where it passes through the eye and along the groove ; and its two ends being joined are wound round the fork two or three times and then put between the division in the fork at *g*, that they may not slip when the ligature is drawn tight. As the distance between the bearing (*e*) and the head of the holder (*b*) increases by turning the handle, the ligature is drawn tighter ; and as the distance

lessens, the ligature slackens. The extent to which the ligature may be tightened is limited to the length of the screw—viz., one inch: should the tightening be extended to this length, the loop of the ligature will be diminished nearly two inches, which is more than sufficient in most cases. A longer screw would lessen the advantage of the groove, and increase the weight of the instrument. In case of an unusually large loop being required to encircle a tumour having a very broad base, should it be found that the action of the screw does not diminish the loop sufficiently, and that for particular reasons the ligature-screw is more convenient than the winder (though, as a general rule, the winder is certainly preferable in such cases), an increased degree of constriction may be obtained in the following manner:—Supporting the holder between the two fingers, but without in the slightest degree altering its position, unwind the ligature from the fork, and return the male screw quite into the female screw; then press the holders more closely to the tumour, and tighten the ligature to such a degree as to cause it to imbed itself into the indentation already made, and fasten the ends in the fork as before. The constriction may thus be renewed *de novo*.

#### OF THE LIGATURE.

9. Many operations are rendered partly, if not wholly ineffectual, merely through neglect in not procuring proper ligatures. Undyed silk is the best adapted for the purpose; as the dye, being more or less destructive, weakens the silk.

Ligatures are composed of silk thread, or of a number of these threads twisted into a cord. Silk thread can only be used when the part to which the ligature is to be applied is not more than two lines diameter; such as excrescences with a small pedicle, small *nævi*, or the trunk of middle-sized vessels. Small silk cords are requisite for larger and firmer parts, such as the spermatic chord, large tumours, and the trunk of the larger vessels. The best description of cord consists of 180 of the finest silk threads tightly twisted three times. Woven cords are inferior; because they are larger and less pliable than those composed of the same number of threads twisted. A smaller cord would not resist the force requisite to produce a sufficient degree of



tension, but would cut through the part encircled ; and a larger would move with difficulty through the eye of the holder, and obstruct the tightening. The eye of the ligature-holder (fig. 4, *a*, *b*) could not be more than one line diameter without the holder being too large and heavy ; through this aperture the twisted cord of 180 single silk threads, being scarcely half a line diameter, moves easily when doubled. A stronger cord is unnecessary, as a yard of this will bear the application of a force equal to thirty pounds ; it is therefore capable of affording more pressure than is at all requisite to the largest and softest parts ; even allowing for its losing in firmness by moisture during the operation. The ligature-silk should be drawn across a piece of hard and clean white wax previous to its being used, in order to prevent the action of wet ; and also to give a slight degree of stiffness to the ligature, which greatly facilitates its application : it should then be nicely smoothed by rubbing it with soft paper to remove the superfluous wax, which might have formed in small lumps, increasing the size of the ligature, or causing irregularities that destroy the round and even surface so essential in its application to deep-seated vessels ; and which is also needed in placing the two ends in the apparatus, and in tightening the ligature. To increase still further the facility of passing the ligature silk through the eye of the holder, and thus diminish the delay in the operation, I have, when preparing the instruments previous to operating, scraped with rather a blunt knife about an inch of each end of the silk cord so thin, that both can be twisted together between the finger and thumb into a fine tapering point. This point will enter easily into the eye of the holder, and, protruding from the other side, can readily be taken hold of and drawn through. The same advantage might also be obtained by fastening a thin silver wire to each end : this, however, is unnecessary if the ends are nicely pointed ; and would not be so convenient, as the length of the ligature cannot always be determined previous to the operation ; there would likewise be greater difficulty and delay in re-preparing the ends, if need were, during the operation. Fig. 14 is one of the pointed ends of the ligature-silk, greatly magnified, in order to shew more plainly the manner in which it is twisted, and to how fine a point it can be scraped.

Fig. 15 is another end, of the real size, pointed with silver wire. At *a* are seen the fine threads of the silk drawn through the bend of the wire, turned back, and again twisted. At *b* is seen the ligature of 180 threads unravelled.

#### OF THE DIRECTING-RODS.

10. The directing-rods (figs. 16 and 17) are necessary in applying the ligature to deeply-seated polypi of the nose, uterus, or other parts which cannot readily be reached with the fingers. Those known as Dessault's have the advantage of a dissevered ring (*d*) at one end of the small rod, (fig. 16,) which is made to open by merely drawing back the tube (*c*), and thus instantly disengage the ligature when it is applied. In fig. 17, the ring is seen open. There is one objection, however, to the use of Dessault's rods—viz. the small tube is very liable to slip down, and thus allow the ring to open inopportunately. This is very apt to occur during deep and difficult applications, when it is necessary to move the rods with some little force, their action being confined by the soft parts closely surrounding them. To obviate this objection, which would cause the necessity of again and again adjusting the ligature, I have had the other end of the rod (*a*) prepared with a double-threaded screw, an inch long, and a corresponding nut (*b*) fitted to it, which will move rapidly up and down the screw: the nut (*b*), being screwed up close to the tube (*c*), prevents it slipping down accidentally, and the ring is kept closed: by turning the nut a little way down the screw, the tube is easily drawn down towards it, and the ring then springs open so far as to disengage the ligature.

The ring is formed out of the two split ends of the small, or inner rod; and, when closed, should be  $1\frac{1}{2}$  line in diameter. It is essential that it should be perfectly round and smooth, in order to lessen, as much as possible, the unavoidable friction in applying the ligature. The length of the directing-rod, from *a* to *d*, is seven inches. Fig. 16 is shortened for the sake of room; in all other respects, it is correct, and of the proper size. Small rods would be inconvenient in the case of deep-seated applications, and could not be used with the requisite firmness. Two rods will generally be found sufficient, even in difficult cases. It must be



an extraordinary case to require three to be employed in applying the ligature properly.

I have myself used this improvement upon Dessault's rods successfully for many years; and have been induced to publish it from seeing the complicated contrivances of the French Surgeons to obtain the same result by means of a spring-stop, as described in the Atlas of Plates to "Velpéau's Médecine Opératoire, 1832."

#### OF THE VARIOUS MODES OF APPLYING THE LIGATURE APPARATUS.

11. Plate 2, fig. 1, represents the ligature applied by means of the winder alone (which is here shewn of its actual size), to a long standing fistula. The ligature is seen passed through the abscess, and, its ends being attached to the hook of the roller, drawn to a slight degree of tension, so that the sides of both openings are brought towards the winder in small folds. Generally, in these cases, the ligature should act with a slight pressure, so as merely to accelerate suppuration; and, therefore, scarcely occasion an unpleasant sensation to the patient: it should by no means be drawn so tight as to cause actual pain. The exact degree of tension requisite being ascertained, the winder should be padded with lint, and secured on one side by a strip of plaister; care being taken to leave the handle free, so that the tightening may easily be continued from time to time, without disturbing the position of the apparatus, or moving the bandage. This mode of applying the ligature is preferable for a patient who has a great dread of the knife; or who is in so weak a state, that the least loss of blood might be of serious consequence;—and also, in cases where the fistula has struck so deep, that cutting would be attended with danger.

12. Plate 2, fig. 2, represents the short holder, combined with the ligature screw, applied to a fistula in *ano*. One end of the ligature is seen passing out at the anus, and the other out of the external opening of the fistula; both ends being fixed in the fork of the screw. In this case, the winder is not so well adapted as the screw, as, from its shape and size, it would be extremely inconvenient in standing and lying down, as well as in sitting; and, moreover, if the fistulous opening were at all near the anus,



the apparatus would be continually soiled. The ligature-screw, combined with the short holder, offers many advantages:—for instance, the smooth round holder can be easily kept clean; the screw is at some little distance from the point of application; and the flatness of the fork-part will not gall in the least, if a good position be chosen for placing the instrument: this must be determined by consulting the convenience of the patient, and can only be ascertained by previous trial; but it will generally be found best, if the situation of the fistulous opening admits of it, to turn the apparatus (padded with lint) upwards, and confine it by a strip of plaister in the cleft of the nates, leaving the handle free, as before mentioned. The tension of the ligature need not be increased at all violently: it may be accomplished by means of the screw in the most gradual manner.

13. Plate 2, fig. 3, represents the ligature-winder applied to an external tumour. This is the case of an infant eight months old, who was born with a *nævus* which rapidly increased in size to two inches diameter and one inch in height. Excision, in the case of a patient of such a tender age, was not advisable. Indeed, from the situation of the tumour on the neck, it would have been dangerous; for, in case of hemorrhage, the degree of pressure requisite to stop it could not be applied. Cautery, of any kind, would have caused inflammation of the wind-pipe; particularly if applied to the very root of the tumour. Relief from this evil, which increased so rapidly as to endanger the life of the infant, was, therefore, only attainable by employing the ligature. I made, round the base of the *nævus*, three incisions, each three-quarters of an inch long, and as directly in a line with one another as possible; taking care to avoid all enlarged veins, of which there were so many, that a complete circumnsion appeared highly objectionable. I then laid the ligature, formed into a loop, over the tumour; held it firmly pressed into the incisions, and tightened it only to such a degree that it could not possibly slip off the swelling, which rose considerably. The ligature was tightened once or twice every day; but never to such a degree as to cause much pain, spasms, difficulty of breathing, or extended local inflammation. At the end of a week, the tumour had separated; and, on the twenty-sixth day, the cure was complete. In the engraving,

the loop of the ligature is concealed by the projecting sides of the tumour; which also prevent the eye of the holder from being seen. The ends of the ligature, passing along the side of the holder, and fastened in the hook on the roller, are distinctly shewn.

14. Plate 2, fig. 4, represents the operation of castration. An incision having been made in the scrotum, the ligature is placed round the spermatic chord, and tightened by means of the apparatus, which consists of the middle-sized ligature-holder, and the winder. The winder is preferable for this operation, because with it the requisite degree of constriction can be more easily obtained; and the pain, which in this operation is unavoidable, is consequently lessened. The safest mode of proceeding is as follows:—Having freed the spermatic chord from its surrounding attachments, raise it slightly with two fingers, and introduce the ligature under it by means of an eye-probe; then pass the ends of the ligature into the apparatus as usual, and turn the handle of the winder—at first, quite slowly, in order to avoid any irregularity, such as the twisting of the ligature; and, having thus brought the end of the holder close to the spermatic chord, turn the handle very quickly, but steadily; and, in a few turns, the requisite degree of constriction will be obtained. A complete division of continuity in the channel of the spermatic chord must be accomplished; for then, and only then, is the division by the ligature as effectual as that by the knife. The degree of constriction when the ligature is drawn deeply into the chord, is ascertained by the tension of the ligature, and by the cessation of the pain that takes place at the last few turns of the winder. The operator will be perfectly assured that no hemorrhage arising from the division of the spermatic vessels can take place; and the chord, now deprived of all sensation, may be divided one-third of an inch below the ligature; the cure will then be completed without suffering to the patient. Sometimes in the case of a greatly-enlarged chord, in which, after a few hours, the ligature forms a very deep indentation, or yields to the great distension to which it is subjected, the constriction will become diminished, and a sensation of tension or heat again occur about the part. Should such be the case, the safest way is immediately



to remove all painful sensations,—not by loosening the ligature, as some very able surgeons have supposed ; but, on the contrary,—by tightening it to the uttermost degree. Formerly, when applying the ligature, the spermatic chord was padded with lint, and the ligature secured only by a single surgical knot, or by a common double knot ; inefficient instruments were employed to tighten the ligature, or due attention was not paid, during or after the operation, to the use of proper instruments ; and the consequences were, frequent local and general nervous symptoms, occasioned by the constriction not being sufficient to destroy the part effectually, which is of essential importance. As these symptoms do not appear in proceeding according to the method which I direct, the operation by ligature is not in itself more likely to occasion spasms of any kind than that of dividing the chord by the knife only. Indeed, a series of observations, made during twenty-five years, has convinced me that Trismus and Tetanus far less frequently follow an efficient constriction by ligature than the use of the knife alone. This arises, in all probability, from the cutting operation being always much more painful, on account of the tedious and agonizing process of taking up and securing each of the spermatic arteries separately ; and also on account of the retraction of some vessels, which frequently causes, both after and during the operation, internal and external hemorrhage ; and sometimes the withdrawal of the spermatic chord altogether within the abdominal ring, requiring a new operation to recover it : thus the patient is not only alarmed, but compelled to suffer renewed pain ; and sometimes even his life is endangered.

Having finished the extirpation, and stopped the slight bleeding which might occur from one of the scrotal arteries, fix the ligature apparatus, padded with lint, close to the abdominal ring, by a slip of plaister ; and, unless peculiar circumstances prevent it, let the wound be drawn together nearly to the spermatic chord, by means of sutures ; that it may heal, as much as possible, by the first intention.

15. Plate 2, fig. 5, shews the ligature placed round the carotis communis, and drawn tight by the screw, combined with the shortest holder. On the outer side of the wound, which is turned towards the handle of the screw, is seen the musc. sterno-cleido-



mastoideus; next to that, the vena jugularis interna; and, between that and the partly-covered carotis, is the nervus vagus: immediately in front of the upper part of the carotis is seen a branch of the nervi hypoglossi, crossed by the musc. omo-hyoideus; nearest to the inner side of the wound, rather low down, is the musc. sterno-thyreoides; and next to it, the sterno-hyoideus: between these and the carotis is the sheath, (rather folded after its division,) which encloses the carotis communis, the vena jugularis, and nervus vagus. The constriction in this, as in all other analogous cases, should only be continued until pulsation of the vessels completely ceases on that side of the loop farthest from the heart. Under these circumstances, the constriction should, on no account, destroy the continuity of the vessel; but, only by checking the action of the blood, cause such irritation in the part confined, that obliteration of the walls of the artery would ensue.

For a further description of the application of this apparatus for the purposes of arterial pressure, vide par. 26, *g*.

16. Plate 2, fig. 6, represents the middle-sized holder combined with the screw in the application of the ligature to a nasal polypus projecting into the mouth. In this drawing, part of the face is removed, in order to shew the position of the holder, and the situation of the ligature round the root of the polypus. To prevent friction, from the apparatus shifting when the patient moves, I pass round the instrument a slip of plaister, and fix each end of it crosswise on the nose; as shewn in the cut. When these polypi which project far into the mouth are too large to bring through the nostril, a ligature should be inserted deep into the polypus, by means of a crooked needle, and the two ends, joined in a knot, be brought to either side, and placed on the ear, to secure the position of the polypus. This should on no account be neglected: and it is further necessary to have the patient watched; for I well remember an instance that occurred some years ago, of a patient dying in consequence of the polypus having unexpectedly fallen off, and caused suffocation.

During the publication of these pages (March, 1833) I publicly applied the ligature to a polypus in a similar situation to that in the drawing; Dr. Büttner, and several other surgeons, being present. The polypus measured, after it was tied, three inches

long, seven-eighths of an inch broad, and seven inches and a half in circumference; although it had been much reduced in bulk by several deep punctures made with a lancet. In this case also, the patient would very likely have been suffocated, had I not taken the precautions before mentioned; for on the third day after the operation, the sudden falling of the apparatus with the entire ligature from the nose, proved that the polypus had separated. It was instantly drawn down from the nose, and out of the mouth; but, although it was done very quickly, the safety-ligature being a great assistance, still it caused a painful, though but a momentary, sensation of suffocation and choking. The patient was perfectly cured in four weeks.

17. Plate 2, fig. 7, is a minute representation of the manner of applying the ligature to deeply-seated and enlarged polypi, which occasion much difficulty in placing and arranging the ligature. The small directing-rods (three of which may be used if needful) retain the ligature in its proper position until it is formed into a loop by the holder, and drawn sufficiently tight for it to be pressed into the part encircled. The rings at the upper extremity of the rods are seen closed; the ligature not being yet tightened. The two ends of the ligature are seen passed through the eye of the holder. When the holder is passed along the ligature to the point of application, and the ligature is drawn tight, the rings of the rods are opened by turning back the small nuts on the screw end, which disengages the rods, and allows them to be withdrawn, as described in par. 10.

18. Plate 2, fig. 8, shews the long holder combined with the winder applied to an uterine polypus. The uterus is cut open to shew the position of the instrument along its entire length, and also the situation of the ligature. Notwithstanding that this apparatus is so much lighter than others, (23, *d*) it is advisable in such cases to support it, in order to prevent inconvenience from friction. The most simple and commodious manner of doing this is, by putting round the hips a band three inches broad, to which the apparatus is fastened by a tape passed once or twice round it; care being taken to fix the instrument in a diverging direction, and as much in front as possible, so as to afford it support without causing distension of the part.

19. Plate 2, fig. 9, shews the winder in operation for the removal



of a ligature-thread firmly attached to an artery. The perforated plate being placed across the wound, the outer end of the ligature is brought through the plate, and through the tube of the winder, and then placed on the small hook of the winder, and drawn to a slight degree of tension. A more elaborate description of this operation is given in par. 27, *h*.

#### SUMMARY OF THE COMPARATIVE MERITS OF THIS APPARATUS.

20. The superiority of this over every other apparatus consists in the following advantages :—

(*a*.) This apparatus can be used with facility and certainty, whether the winder alone be employed, or the winder or the screw in combination with either holder; in applying the ligature externally, under the skin, to parts deeply seated, or between muscles. No one ligature apparatus hitherto known is capable of such universal application, without some objection to its use.

21. (*b*.) The peculiar construction of these instruments allows of their application without any difficulty, even during an operation, should any unforeseen circumstances render it necessary. The holders can readily be changed, should one too long or too short have been at first selected, without either disturbing the ligature or removing the directing-rods (when the latter have been used in placing the ligature); and the winder can be readily exchanged for the screw, or *vice versa*. Any or all of these alterations can be made in a few moments, without inconvenience either to the patient or the operator.

22. (*c*.) The extreme facility with which the ligature is adjusted to this apparatus, is an advantage possessed by no other. The most prominent in this respect are, the rosary, or bead ligature-holders of Bouché, Herbiniaux, Görz, and others, consisting of a number of beads strung upon the ligature. These were intended to accomplish a two-fold object—viz., an unlimited variety of length, and such flexibility as to yield to the increased size of the encircled part. The variety of length, in my apparatus, is obtained quite satisfactorily by the different combinations already described, without such loss of time as is unavoidable in using the beads. Moreover, the flexibility of the rosary only lasts so long as the ligature is loose, when the beads of course follow any direc-



tion; but as soon as the ligature is drawn to the requisite degree of tightness, it will be found that they become equally as stiff and inflexible as any other instrument. During the tightening of the ligature, therefore, the holders of either kind can only be in a line with the encircled part when it is small; with very projecting parts, such as enlarged polypi, &c., they must take a slanting direction. This is of no consequence, if care be taken to place the instrument on the side where there is most room, in applying the ligature either to the nose, mouth, vagina, or uterus. It is well known, that Levret, and many other eminent surgeons have succeeded, in cases of very large uterine polypi, with straight and inflexible holders; and I have never found the least difficulty in successfully applying ligatures, with my apparatus, to any kind of the largest polypi. As the rosary, therefore, is not superior with regard to its position between soft parts, it has no advantage in this respect over my holders; and the great trouble of passing the ligature through the beads, renders its use objectionable: for though this may be of no moment when it is only necessary to put the loop over the tumour (as the ligature with its rosary can be prepared beforehand) it will certainly encroach greatly upon the time and patience of the operator, when he has to pass the ligature through 40, 60, and sometimes 80 beads, before he can finish the operation; it having been necessary to leave the ligature quite free, in order to lay it round the parts to be encircled. Brunninghausen thought to obviate this difficulty, by substituting for the beads small tubes about an inch long, fitting into each other. This plan, undoubtedly, required a less frequent passing of the ligature, as a much smaller number of tubes was necessary; still more time would be consumed in passing the ligature through each tube, as it would not be so easy to thread them as the beads. The small single and double canulæ, of 4, 6, and 8 inches long, as used by Levret, Brambilla, Bell, Gooch, and others, offer the greatest difficulty to passing the ligature, on account of their length; unless they are made very large, in which case the weight and bulk of the apparatus being greatly increased, it is rendered highly objectionable. Löffler tried two slightly bent metal rods, with a ring at the end, and three eyes on the side; but with this apparatus, much delay is occasioned by the necessity of passing the ligature four

several times to each rod, making eight times. It is, besides, much confined in its application ; owing to several circumstances, which need not here be explained. Having long been sensible of this inconvenience, I endeavoured, in 1815, to remedy it by using two double tubes, split their whole length, and fitted one within the other ; so that by pressing the ligature through the slit and turning the outer tube a quarter round the inner one, it would be completely closed in. Dr. Bieler also has repeatedly tried this contrivance. With my new ligature-holder, however, the ligature is adjusted much quicker, and with greater certainty ; it being only necessary to pass the ligature through a single eye half a line in depth, and attach it to the winder.

23. (*d.*) The extreme lightness of this apparatus is an important advantage ; the inconvenience caused by the weight of the others being entirely avoided. The whole weight of the apparatus, when the winder is employed in combination with either holder, is not one quarter that of any other ; indeed, it is two-thirds, and even four-fifths lighter than some.

24. (*e.*) The size and form of the apparatus should likewise be considered, with reference both to the holders, which are employed in internal operations, and the winders, which are used alone in those which are external. It will be found that these not only occupy much less room than any hitherto employed, but that they are perfectly free from any sharp edges or projections, which are sources of much annoyance. These holders are throughout smooth round rods, not more than two lines wide ; whereas the double canulæ of Levret and Görtz are more than half an inch wide. The winder, including the handle, is only ten lines, and the screw is but five lines ; whereas those of Brunninghausen and others are an inch and a half, and two inches broad. It is, therefore, very evident that in the same situation, and under the same circumstances, instruments larger, and of a less rounded form, would be found very far inferior in utility and completeness ; besides causing great inconvenience by pressure and extension of the parts.

25. (*f.*) The advantage of having a choice of two differently constructed windlasses is also considerable. It would at first sight appear, that the winder, which may be joined to either holder, might



be made to supersede the use of the screw. This may be the case in many instances, but certainly not under every variety of circumstances : for instance, when it is necessary that the ligature should be gradually and almost imperceptibly tightened, this can be accomplished in a much more satisfactory manner by means of the screw ; which, besides being only half the width of the winder, obviates the inconvenience incidental to the wearing of a larger and heavier instrument. These excellent qualities induced Dupuytryen, and other French surgeons, to imitate the mechanism of my apparatus in a variety of ways. At all events, the possession of two windlasses, if attended with no other benefit, would enable the operator to substitute one for the other, should either be in any way injured : there are few cases, however, in which one would not be, in some respects, preferable to the other.

26. (*g.*) This apparatus is admirably calculated to produce arterial pressure. The instruments recommended for this purpose by Deschamps, Ayrer, Scarpa, and Bujalski, have each affixed to that end which comes in contact with the artery, a square plate at right angles with the stem. This plate has a hole for the reception of the ligature ; and projects either on one side only, as in Eckhold's, or from both sides, as in Deschamps', &c. The plates are not very small either, some measuring half or three-quarters of an inch long, and a quarter broad ; and their removal from the wound is as painful and difficult as disengaging a barbed hook. Even when the wound is kept open with lint, greatly to the inconvenience of the patient, the soft parts will project over the plate ; particularly in the case of a deeply-seated artery. When the ligature is required to remain till the third or fifth day, and the inflammation has subsided, and the process of healing commenced round the stem of the instrument, the ligature may be easily brought away, but not the instrument. Its removal can only be effected with much painful laceration of the parts, which often causes hemorrhage to a considerable, and sometimes a dangerous, extent. With my ligature-holder,—which is a small tube, perfectly free from any hooked projections, and as round and smooth as a sound,—the wound may be allowed to close ; and, although it were to heal all round, the small thin cylinder might be easily removed, without any separation where



adhesion had taken place, and without the least pain. In withdrawing the ligature-holder, I proceed in two different ways, according as the obliteration of the artery is certain or doubtful; the latter being sometimes the case in very difficult circumstances. In ordinary cases, where the result of the operation is certain, I insert, close to the winder, and between the two threads of the ligature, one blade of a pair of scissors, and, with the blades close to the skin, cut the thread as near the wound as possible; then, by the most gentle turning of the instrument, I gradually raise it, together with the ligature, from the wound. To prevent the least disturbance of the parts beneath, I place two fingers, with a light pressure, close to the instrument. Those rare cases, where, after the lapse of some days, it is uncertain that the tightenings of the ligature may not have to be repeated, I unloose the ligature from the winder, and separate it from the holder as far as the wound; then, with two fingers keeping back the surrounding parts, I raise the holder, without moving the ligature from its position round the artery. Should it be necessary to repeat the tightening, the two ends of the ligature hanging from the wound, must be passed, as before described, through the eye of the holder, and the holder be gradually inserted in the wound along the ligature, which forms a sure guide until it reach the artery: the ligature is then fastened to the winder, and drawn quite tight. This process would be utterly impracticable with the other instruments for arterial pressure, without tearing open the whole wound, or again having recourse to the knife. No surgeon who, at the bedside of a patient, has an opportunity of comparing this instrument with others, can hesitate for a moment to give mine the preference.

27. (*h.*) This apparatus also supersedes the various contrivances for removing the ligature from an artery where it has remained for several weeks, preventing the wound from healing. The occasion for its use is more fully explained in my publication of a peculiar Apparatus for the removal of such ligatures. Instruments for the purpose will always be necessary, while the consequence of allowing a wound to close upon a ligature is so far from being placed beyond all doubt. Referring, therefore, to this publication, I will only mention the additions necessary to my apparatus for this purpose. Through the centre of a plate of ivory, ebony,

or lead, one-inch-and-a-half long, and half-an-inch broad, a hole should be made large enough to receive the ligature, but not so large as to admit the small tube of the winder, (plate 1, fig. 10, *d*,) which would irritate the wound. The size mentioned for the plates will be generally found sufficient, they being supported on each side of the wound;—it would be useless to cover the wound entirely. Having a small plate thus prepared, or, in case of emergency, a piece of money perforated, the ligature is passed through the small tube of the winder, and fixed on the roller; it is then drawn carefully to so slight a degree of tightness as neither to cause pain, nor even the sensation of tension. By carefully keeping the ligature thus, it will come away in forty-eight hours. I have never known an accident to happen in this process,—it is so gentle, and free from pain. It may be necessary to state, that, although I have, for a considerable period, made use of the ligature-screw and holder, I consider the winder much better adapted for this purpose.

28. (*i.*) With respect to the various applications of my ligature apparatus, it ought to be remembered that, besides those already mentioned, it can be adapted in a great variety of cases. I have employed it, not only for the removal of polypi of the ear, nose, mouth, uterus, and rectum; for the application of the ligature to large vessels in aneurism of the thigh and upper arm, and to the carotid and anonyma; and for the removal of ligatures firmly attached to arteries; but I have also used it for dividing the spermatic chord in castration; for the removal of the penis; and for the radical cure of the cylindrical form of umbilical rupture in infants. The apparatus answers admirably well in tying a long and old fistula when the separation of its walls is necessary, and the use of the knife is objectionable. When such fistulæ have two openings, the ligature should be passed through by means of an eye-probe; and, when there is only one opening, as in cases of blind fistulæ, another could easily be made for the introduction of the ligature. I have also employed the apparatus for the destruction of various forms of excrescences, in cases where the ligature would be preferred to the knife. This I accomplished by laying the ligature at once round the base of the tumour; or, where the stem was not sufficiently formed to ensure



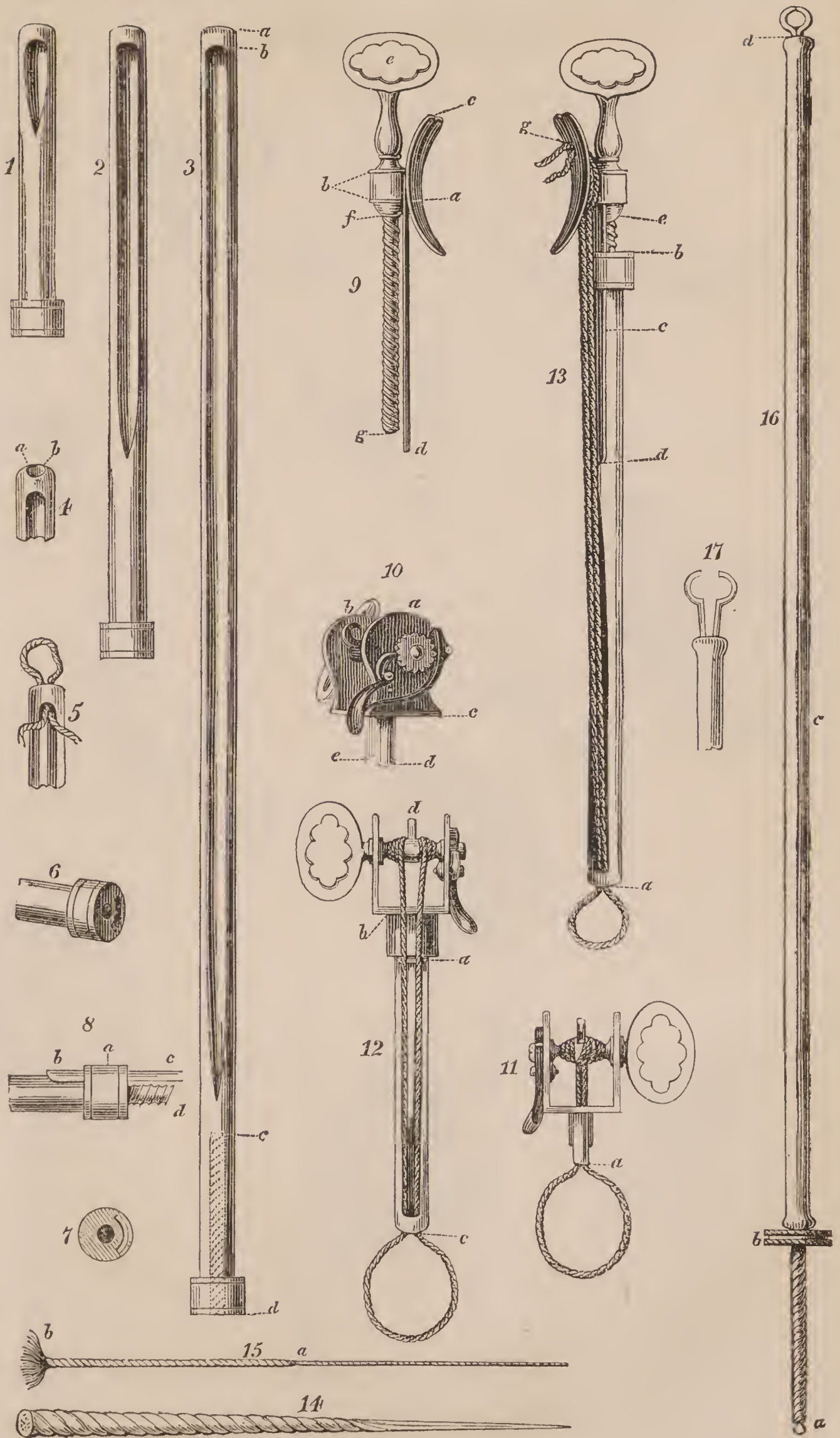
the hold of the ligature, by a slight incision near the base of the tumour, which prevents the ligature slipping off. The incision was made sometimes quite round the tumour; at others, only for an inch on one or both sides, according to its size, or according to the absence or intervention of blood-vessels. The incision should, in all cases, be sufficiently deep to prevent the possibility of the ligature slipping off when very tightly drawn into the wound. By these means, foetal marks and nævi have been successfully removed, when excision would have been dangerous. These operations have been performed with my apparatus both in its early and its present state; and accounts of them have been published by myself, and other surgeons.

29. (*h.*) It should be borne in mind, that all the before-mentioned operations have been performed with my apparatus, consisting of five pieces, where fifteen or twenty instruments of other kinds would have been necessary.





# DR. GRAEFE'S LIGATURE APPARATUS.



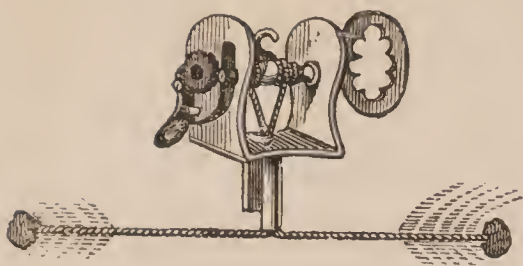
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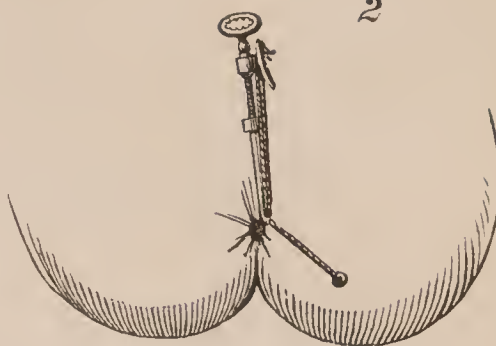


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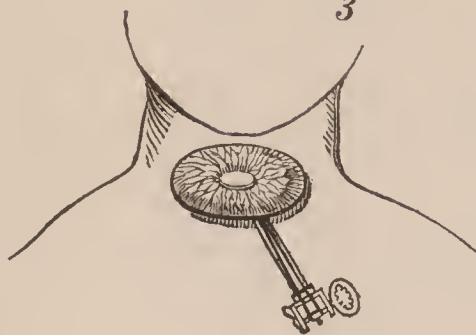
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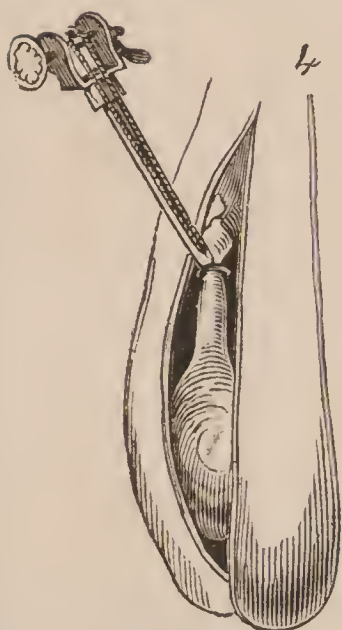
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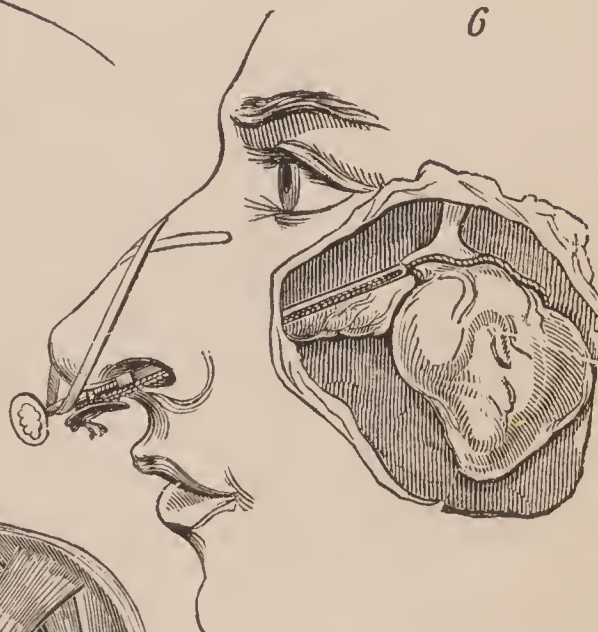
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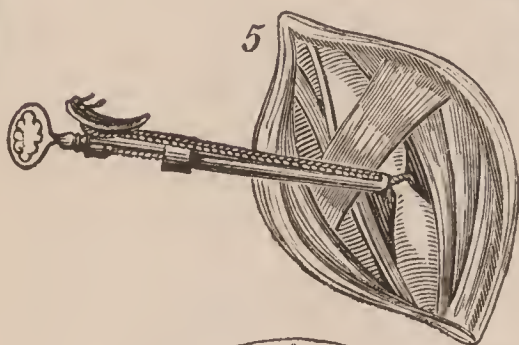
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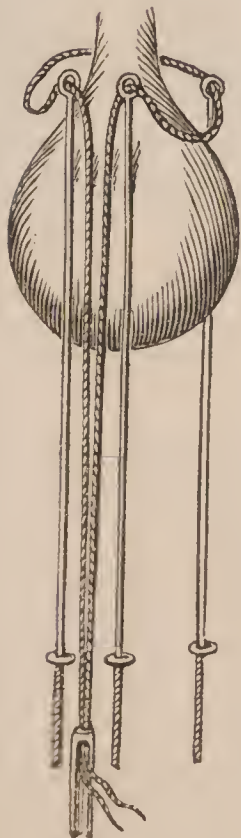
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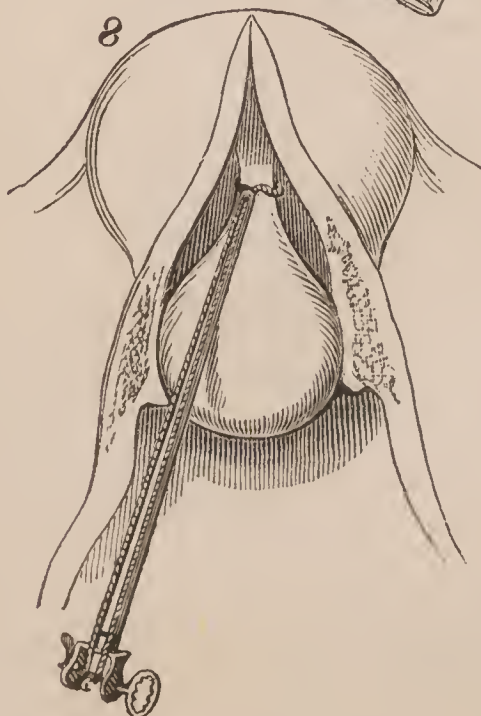
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